REMARKS

Applicant would like to thank the Examiner for the careful consideration given the present application. The application has been carefully reviewed in light of the Office action, and amended as deemed necessary to place the application into condition for allowance.

Specifically, by this amendment claim 1 has been amended and claims 2, 6 and 7 have been canceled. No new claims have been added to the application. Accordingly, claims 1 and 3-5 are pending in the application. No new matter has been added.

In the prior Office Action, the Examiner rejected claims 1 and 2 under 35 U.S.C. §103(a) as being unpatentable over Nakazawa et al. (US 6,274,805) in view of Basol et al. (JP 11-340482), Takeshi (JP 08-126206) and Taiyo (JP 61-15763). In view of the amendments to claim 1 and for the reasons set forth below, applicant respectfully requests reconsideration of the rejection of claim 1.

As noted by the Examiner, Nakazawa et al. is directed to a chalcopyrite type solar cell comprising a stack retained on a flexible insulative substrate. The stack includes a first electrode composed of a metal, a light adsorption layer formed on or above the first electrode, which is composed of a chalcopyrite type compound serving as a P-type semiconductor, and a second electrode formed on or above the light adsorption layer which serves as an N-type semiconductor. However, as conceded by the Examiner, Nakazawa et al. does not disclose:

- mica being contained in an insulative substrate that retains said stack;
- a smoothing layer having irregularities on an upper end surface thereof being provided between said insulative substrate and said stack, said irregularities

of the smoothing layer being smaller than irregularities on an upper end surface of said insulative layer; and

- two binder layers being interposed between said insulative substrate and said stack such that said two binder layers sandwich said smoothing layer.

The Examiner cites Basol et al. (paragraph [0017]) as support for the proposition that it is known that mica can be used in substrates of chalcopyrite type solar cells. The Examiner cites Taiyo (p. 4, lines 25-31 and p. 5, line 11-15) for the proposition that it is known that glass pastes can be used to make a smoothing layer having irregularities on an upper end surface that are smaller than irregularities on an upper end surface of an insulative layer containing mica on which the smoothing layer is formed. And, the Examiner cites Takeshi (Abstract) for the proposition that it is known that a TiN binder layer can be formed between two layers to prevent peeling of an alloy film regardless of heat treatment. Based on the foregoing, the Examiner concludes that it would have been obvious to one of ordinary skill in the art at the time of the invention to utilize a mica substrate in chalcopyrite type solar cell such as disclosed in Nakazawa et al., to use a smoothing layer on the mica substrate as taught by Taiyo, and to use TiN binder layers to sandwich the smoothing layer of taught by Taiyo to prevent peeling of the film regardless of heat treatment. Applicant respectfully disagrees.

Applicant notes that Takeshi teaches (see Fig. 1) the use of a single TiN binder layer 11 disposed between a soft glass substrate 1 and a metal layer 2. Takeshi does not teach a binder layer between a smoothing layer and a mica-containing substrate and does not teach a binder layer between a smoothing layer and a first electrode of a chalcopyrite type solar cell as claimed. Furthermore, Takeshi does not specify the thickness of the single binder layer between the glass substrate and the metal layer.

Applicant also notes that the reference the Examiner seeks to modify in view of Takeshi, namely Nakazawa et al., already discloses the use of TiN layers in a chalcopyrite type solar cell. Nakazawa et al. first discloses the use of TiN film as a reinforcing layer 6 (see Fig. 2), which is disposed beneath the substrate 1 opposite the metal electrode layer 2 to prevent warping of the flexible substrate (see col. 5, lines 47, to col. 6, line 14). And, Nakazawa et al. also discloses the use of a TiN film as a bonding layer between the electrode layer formed on the substrate and the semiconductor layer of the chalcopyrite structure (see col. 6, lines 15-29). Nakazawa et al. teaches that this bonding layer should have a thickness of 0.01 to 0.1 μm (see col. 6, lines 28-29).

Claim 1 has been amended to clarify that a binder layer and a diffusion-preventive layer are interposed between said insulative substrate and said stack such that said binder layer and said diffusion-preventive layer sandwich said smoothing layer, said diffusion-preventive layer being provided between said smoothing layer and said insulative substrate and preventing diffusion of impurities from said insulative substrate, each of said binder layer and said diffusion-preventive layer containing TiN or TaN, and each of said binder layer and said diffusion-preventive layer having a thickness of 0.5 to 1 μm. The Examiner concedes that the prior art does not teach layers having the thickness limitation now set forth in claim 1, but argues that it would have been obvious to use a TiN film having such thickness to prevent peeling of adjacent layers during heat treatment. Applicant respectfully submits that it is not permissible to make such a conclusion in the absence of some evidence or logic supporting it.

Nakazawa et al. clearly shows that layers of TiN need only to be relatively thin, e.g. 0.01 to 0.1 μm (see col. 6, lines 28-29), to perform the bonding function between two layers. Thus, a binding layer 5 times thicker than taught for that purpose would not be obvious for the "peeling" problem which serves as the Examiner's justification. Furthermore, applicant notes that the binder layer in applicant's claimed chalcopyrite type solar cell is not utilized solely for a binding function. As noted in the specification, the TiN or TaN binder layer preferably has a thickness of at least 0.5 μm so that the binder layers can serve as barrier layer to prevent the migration of impurities from the mica-containing substrate to the light absorption layer (see page. 13, line 10 through page 14, line 4). Furthermore, the specification teaches that the binding layer should not 1 μm because a thickness greater than 1 μm may degrade the joining strength of the binder layer. The thickness and purpose of applicant's binding layers is not taught in the prior art of record.

The cited references do not note the problem caused by the impurities contained in the mica aggregate substrate. If the diffusion of the impurities from the substrate is not prevented, the impurities may diffuse into the light absorption layer and adversely affect the function of the light absorption layer. The present invention solves such a problem.

To reliably prevent the diffusion of the impurities, the thickness of the diffusion-preventive layer should be 0.5 μm or more. On the other hand, to keep the bonding strength, the thickness of the diffusion-preventive layer should be 1 μm or less.

Furthermore, the diffusion-preventive layer is provided between the smoothing layer and the substrate also to enhance the bondability between the smoothing layer

and the substrate. The cited references also fail to disclose or suggest such a structure.

Although Nakazawa et t al. discloses a bonding layer 7 provided between a first electrode layer 2 and a semiconductor layer 3 of a chalcopyrite structure, the bonding layer 7 is a thin film of Te, Sn, Ti, Ta or Ci, or a mixed composition containing at least one of the elements. In the Example, the bonding layer comprises a chromium layer. The Nakazawa et al. reference does not explicitly suggest the use of TiN or TaN in the bonding layer.

Applicant respectfully submits that the Examiner's combination of Nakazawa et al., Basol et al., Takeshi and Taiyo fails to establish a *prima facie* case of obviousness with respect to claim 1 inasmuch as no reference teaches the presence of two TiN or TaN binder layers in a chalcopyrite type solar cell, wherein one of the layers is disposed between a smoothing layer and a first electrode and the other of the layers is disposed between the smoothing layer and a mica-containing substrate. For that matter, there is no reference of record that teaches the use of a TiN or a TaN binder layer between a smoothing layer and a first electrode, and no reference of record that teaches the use of a TiN or a TaN binder layer disposed between the smoothing layer and a mica-containing substrate. And, as noted above, there is no reference of record that teaches that such TiN or TaN binder layers should have a thickness of 0.5 to 1 μm. While it might have been possible, with the hindsight afforded by applicant's specification, to find the various layers in the prior art, there is no such teaching in the prior art that would have made it obvious to combine them in the way applicant did. Accordingly, claim 1 is clearly patentable over the prior art.

Claims 3-5 depend from claim 1 directly or though an intervening claim. Accordingly, claims 3-5 are also patentable over the prior art of record for the same reasons that claim 1 is patentable over the prior art of record.

In light of the foregoing, it is respectfully submitted that the present application is in a condition for allowance and notice to that effect is hereby requested. If it is determined that the application is not in a condition for allowance, the Examiner is invited to initiate a telephone interview with the undersigned attorney to expedite prosecution of the present application.

If there are any additional fees resulting from this communication, please charge same to our Deposit Account No. 18-0160, our Order No. TOH-16912.

Respectfully submitted,

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